

AD-753 483

UV GAS LASER STUDIES

Northrop Research and Technology Center

Prepared for:

Advanced Research Projects Agency  
Office of Naval Research

November 1972

DISTRIBUTED BY:

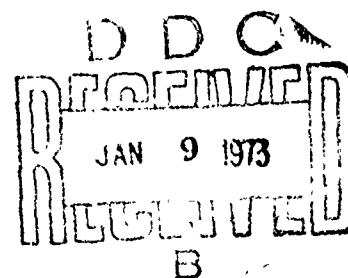
**NTIS**

National Technical Information Service  
U. S. DEPARTMENT OF COMMERCE  
5285 Port Royal Road, Springfield Va. 22151

AD753483

UV GAS LASER STUDIES  
SEMI ANNUAL TECHNICAL REPORT

November 1972



NATIONAL TECHNICAL  
INFORMATION SERVICE

**NORTHROP CORPORATION**

LASER SYSTEMS DEPARTMENT  
3401 West Brook  
Hawthorne, California 90250

DISTRIBUTION STATEMENT A

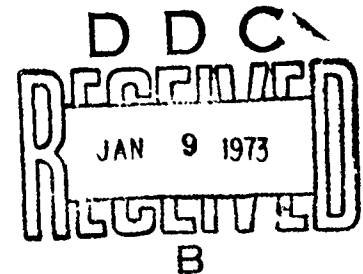
Approved for public release;  
Distribution Unlimited

UV GAS LASER STUDIES  
SEMI ANNUAL TECHNICAL REPORT

November 1972

Prepared by

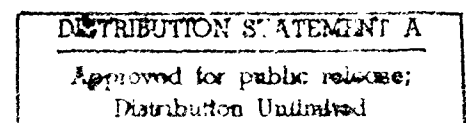
Laser Technology Laboratories



The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Advanced Research Projects Agency or the U. S. Government.

NORTHROP CORPORATION  
Northrop Research and Technology Center  
Laser Technology Laboratories  
3401 W. Broadway  
Hawthorne, California 90250

T-6



UNCLASSIFIED

Security Classification

## DOCUMENT CONTROL DATA - R &amp; D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Northrop Corporation, Northrop Research and Technology Center, Laser Technology Laboratories, 3401 W. Broadway, Hawthorne, California 90250		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP -	
3. REPORT TITLE  UV Gas Laser Studies			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Semi Annual Technical Report			
5. AUTHOR(S) (First name, middle initial, last name) Laser Technology Laboratories			
6. REPORT DATE November 1972		7a. TOTAL NO. OF PAGES 25 31	7b. NO. OF PAGES 0
8a. CONTRACT OR GRANT NO. N00014-72-C-0456		9a. ORIGINATOR'S REPORT NUMBER(S) NRTC 72-14R	
b. PROJECT NO.		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) none	
c.			
d.			
10. DISTRIBUTION STATEMENT  Distribution of this document is unlimited.			
11. SUPPLEMENTARY NOTES  none		12. SPONSORING MILITARY ACTIVITY  Advanced Research Projects Agency	
13. ABSTRACT  A series of spectral measurements were carried out to demonstrate the feasibility of achieving stimulated emission in the vacuum ultraviolet using molecular xenon gas excited by a relativistic electron beam from a Febetron 705. Both longitudinal and transverse excitation schemes were used with gas pressures up to 30 atmospheres. The xenon emission spectrum at 3 atm consisted of a 150A wide band centered around 1750A. At higher pressures (20 atm) indication of a preferential intensity build up at several parts of the spectrum was recognizable over the broad continuum. This preferential build up disappeared when one of the cavity mirrors was taken out. Since no significant line narrowing was observed, the conclusion from the spectral studies using the Febetron 705 is that the evidence of stimulated emission in molecular xenon is at best marginal.			

UNCLASSIFIED

Security Classification

KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Stimulated Emission Molecular xenon Vacuum ultraviolet						

T-1.

UNCLASSIFIED

Security Classification

UV GAS LASER STUDIES

ARPA Order Number:	1807
Program Code Number:	421
Contract Number:	N00014-72-C-0456
Principal Investigator and Phone Number:	Dr. M. L. Blomnik (214) 311, Ext. 4756
Name of Contractor:	Northrop Corporation Northrop Research and Technology Center Laser Technology Laboratories 3401 W. Broadway Hawthorne, California 90250
Scientific Officer:	Director, Physics Programs Physical Sciences Division Office of Naval Research Department of the Navy 800 N. Quincy Street Arlington, Virginia 22217
Effective date of Contract:	15 April 1972 to 31 December 1972
Amount of Contract:	\$70,000.00
Sponsored by:	Advanced Research Projects Agency ARPA Order No. 1807
Distribution Statement:	Distribution is unlimited.

"Reproduction in whole or in part is permitted for any purpose of the United States Government."

TABLE OF CONTENTS

1.0	SUMMARY	1
2.0	INTRODUCTION	4
3.0	EXPERIMENTAL ARRANGEMENTS	5
4.0	LONGITUDINAL EXCITATION	8
	4.1 Cavity Design and Construction	8
	4.2 Laser Diagnostics	12
	4.3 E-Beam Scattering	15
5.0	TRANSVERSE EXCITATION	20
	5.1 Cavity Design and Construction	20
	5.2 Laser Diagnostics	20
	5.3 Pressure Wave Analysis	24

## 1.0 SUMMARY

A series of spectral measurements were carried out to demonstrate the feasibility of achieving stimulated emission in the vacuum ultraviolet (VUV) using molecular xenon gas excited with a relativistic electron beam. The E-beam of peak current density  $1800 \text{ amps/cm}^2$  and  $\sim 20 \text{ nsec}$  duration with an average electron energy of 1.8 Mev was provided by the Northrop Febetron 705. Both longitudinal and transverse excitation schemes were used with gas pressures up to 30 atm. The major emphasis was placed on spectral measurements since line narrowing is considered the most convincing evidence for stimulated emission.

In the longitudinal excitation scheme, the 10 cm long optical cavity consisted of a 2 mil thick totally reflective, aluminum coated flat mica mirror, and a flat output mirror consisting of an aluminum coated  $\text{MgF}_2$  substrate. The cavity was placed inside a chamber which could be pressurized up to 30 atm. The E-beam entered the pressure chamber through a 3 mil thick titanium foil and into the optical cavity through the mica mirror. The radiation from the output mirror was directed through an evacuated chamber to a SPEX 3/4 meter spectrograph (Model 1700) equipped for the VUV region. The spectra were recorded on a Kodak 101-01 special UV film and analyzed with the help of a Jarrell-Ash densitometer.

The  $\text{Xe}_2$  emission spectrum with the E-beam excitation consisted of a broad ( $\sim 150\text{\AA}$ ) band centered around  $1750\text{\AA}$  at 1 atm. As the pressure was increased the spectrum became narrower. At 20 atm, using a 1.8 Mev beam, the spectrum consisted of 3 narrow bands each about  $10\text{\AA}$  wide with a separation of 8- $10\text{\AA}$  between the bands. The observed spectral line narrowing could indicate gain in high pressure Xe gas under E-beam

excitation. However, from our experimental study of the absorption of the 20 atm Xe, it was concluded that the observed line narrowing could be attributed to absorption by the Xe gas or some minute impurities (possibly  $O_2$ ) present in it.

Measurements with a Faraday cup indicated that the E-beam current density decreased rapidly as a result of scattering by the foil and its support structure as well as by the high pressure gas. This decrease was in addition to the 40% obscuration by the support structure. Under these conditions, it was estimated that only the first 2 cm of the medium would have had sufficient gain for lasing. It was therefore decided to abandon the longitudinal geometry and use a transverse excitation scheme. With this modification, the problem of using a thin E-beam transmitting mirror was eliminated so that a mechanically more stable cavity could be designed. Also it was possible to move the titanium foil window closer to the Febetron exit foil to get a higher electron density.

The 8 cm long transverse cavity was excited by the E-beam, introduced through one side of the cavity, providing a gain length of nearly 2 cm. No significant line narrowing was observed using this geometry either. However, the output mirror shattered after a few shots. The shattering of the mirror was attributed to damage by pressure waves following the Febetron excitation. Our analysis shows that this problem may be overcome by properly designing the cavity and also by using a stronger mirror substrate like quartz.

The only significant result from both the longitudinal and transverse cavity experiments is that when fresh xenon was used, indication of preferential intensity buildup at some parts of the spectrum was recognizable over a

broad continuum. This preferential buildup disappeared when one of the cavity mirrors was taken out. The conclusion from the investigation using the Febetron 705 is that the evidence for stimulated emission in molecular xenon gas is at best marginal. This is possibly due to the small gain length available with a Febetron E-beam.

## 2.0 INTRODUCTION

High power/high energy lasers with high overall efficiency are of considerable interest for various applications. In this respect, a potentially new class of lasers, now being called the "molecular association" lasers, deserves a more thorough investigation. Since these molecules have a repulsive ground state, any population of the stable upper state leads to 100% inversion. This combined with their high quantum efficiency indicates the possibility of achieving a very high overall laser efficiency. Furthermore, radiation from these molecules covers the spectral region from the near infrared all the way to the vacuum ultraviolet, suggesting the possibility of a high efficiency laser at short wavelengths.

For this purpose the noble gas molecules are especially significant because of their emission in the vacuum ultraviolet. Basov and co-workers in Russia have reported spectral evidence of stimulated emission in molecular xenon liquid with an indicated conversion efficiency of 50%. We have undertaken an investigation of the xenon UV laser in the gas phase with the ultimate goal of understanding the characteristics of xenon and other "molecular association" lasers. The accomplishments of the investigation to date are described in detail in the following sections.

### 3.0 EXPERIMENTAL ARRANGEMENTS

The experimental arrangement, to obtain evidence of stimulated emission in molecular xenon gas, is schematically shown in Figure 1. It consisted of an optical cavity inside a high pressure gas cell, a high energy E-beam for excitation, and a spectrograph for laser diagnostics. The high pressure (10-40 atm) was necessary since the excited states of molecular xenon gas are formed via three body collisions. The E-beam excitation was the most convenient method to pump sufficient energy within the lifetime of the excited molecular states and have sufficient gain to exhibit stimulated emission. The E-beam was supplied by a commercial field emission device (Field Emission Inc. Model 705). This beam had the following characteristics:

Table I. Characteristics of Febetron 705

Peak Energy	2.3 MeV
Average Energy	1.8 MeV
Pulse Duration	20 ns, (FWHM)
Transmitted Beam Current Density	1800 amp/cm <sup>2</sup> (peak on axis)
Beam Diameter at Window	~ 1 cm (FWHM)
Focusing Field (over cathode region)	~ 4 kG

After passing through the anode of the field emission E-gun, the beam was transmitted less than 1 cm in air to the window of the 40 atm pressure cell. The optical cavity was housed within the pressure cell so that the static pressure on both sides of the cavity mirrors could be the same. This greatly reduced the mechanical requirements on the optical components and their mounts. The details of the cavity design and construction are discussed in Sections 4.1 and 5.1.

The laser diagnostics were primarily accomplished by spectral measurements to observe spectral line narrowing. The electrical noise in the Febetron room

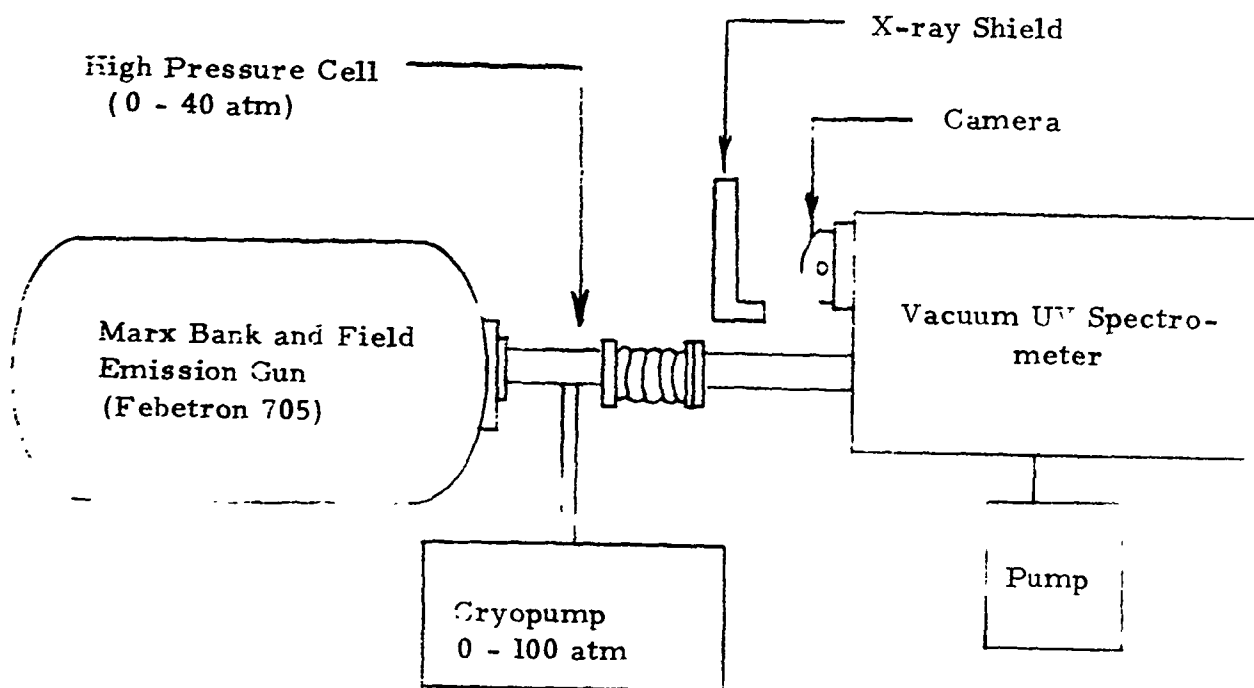


Figure 1. Experimental configuration.

was too severe to rely on electrical measurements like pulse narrowing to give a conclusive evidence of lasing. On the other hand, spectral measurements are independent of any such electrical noise and could provide straightforward, convincing evidence of stimulated emission.

The spectral measurements were carried out by means of a SPEX 3/4 meter vacuum UV spectrograph Model 1700 provided with a 1200 lines/mm grating blazed at 1500Å. The dispersion of the spectrograph near 1700Å was ~10Å/mm with a maximum resolution of 0.1Å. The spectrograph was calibrated with the Xe atomic resonance line at 1470Å. Radiation from the laser cell was directed through an evacuated chamber to the spectrograph and was recorded on Kodak 101-01 special UV film. The spectra were analyzed with a Jarrell-Ash densitometer.

The internal pressure of the spectrograph was maintained at  $10^{-6}$  torr to minimize absorption by residual gas in the optical path. In most of the experiments sufficient radiation was available to give an acceptable optical density in one shot with a spectrograph slit width of 250 $\mu$  or larger. This limited the resolution of the spectrometer to nearly 1Å.

A cryopumping system was employed to pressurize the cell. The desired amount of gas was frozen out at 77°K in a high pressure stainless steel bottle. When warmed to room temperature the pressure increased to the value determined by the amount of gas and the volume of the bottle. Attempts were made to maintain the gas purity by carefully pumping all gas containers to less than  $10^{-5}$  torr and by using metal seals wherever possible.

The entire experimental setup was enclosed in an x-ray shielded room for protection of laboratory personnel from hard x-rays produced by electrons scattered from metal surfaces. The spectrograph camera had to be shielded by lead blocks to keep the x-rays from fogging the film. The excitation schemes and the results are discussed in the following sections.

#### 4.0 LONGITUDINAL EXCITATION

Since the diameter of the E-beam from the Febetron was small and the energy of the beam was sufficiently high to have a stopping distance of  $\sim 10$  cm in 20 atm of xenon, a longitudinal excitation scheme was first chosen.

4.1 Cavity Design and Construction. The laser cell is shown schematically in Figure 2. The E-beam entered the gas cell through a 3 mil thick titanium foil supported by a foil support structure with an obscuration of  $\sim 40\%$ . The E-beam was admitted into the optical cavity through a totally reflective mica mirror. The mica mirror was made by stretching a 2 mil thick mica sheet over a stainless steel clamping ring and then coating the flat substrate with Al with a protective overcoat of  $\text{MgF}_2$ . The output mirror was obtained using the same coating on a 4 mm thick  $\text{MgF}_2$  substrate. The radiation from the output mirror passed through another  $\text{MgF}_2$  flat which isolated the high pressure of the cavity.  $\text{MgF}_2$  flats were used for transmission optics in all the experiments since it is resistant to solarization and radiation damage.

For fabrication of the laser cell, a construction with commercially available stainless steel vacuum hardware was used to allow quick modification of the cell. A photograph of the components of the pressure cell and optical cavity is shown in Figure 3 while Figure 4 shows the assembled cell installed on the E-gun. The entire cell could be bolted onto the Febetron faceplate to provide mechanical rigidity and a low inductance current return for the E-beam current.

Both mirrors were coated for maximum reflectance estimated from transmission measurements to be 90-97% at 1750A. The magnesium fluoride mirror was set in an adjustable mount and was aligned parallel to the mica mirror with a He-Ne laser.

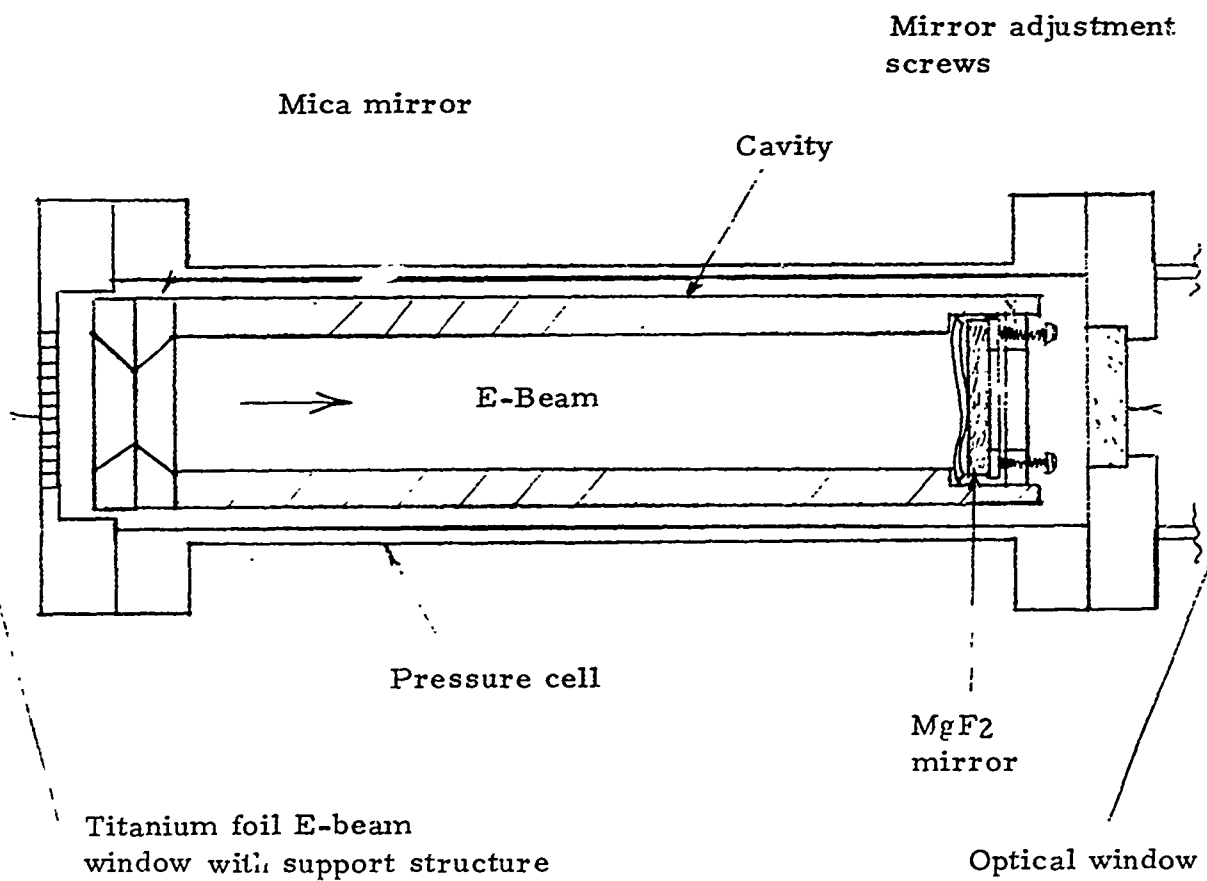


Figure 2. Longitudinal pressure cell.

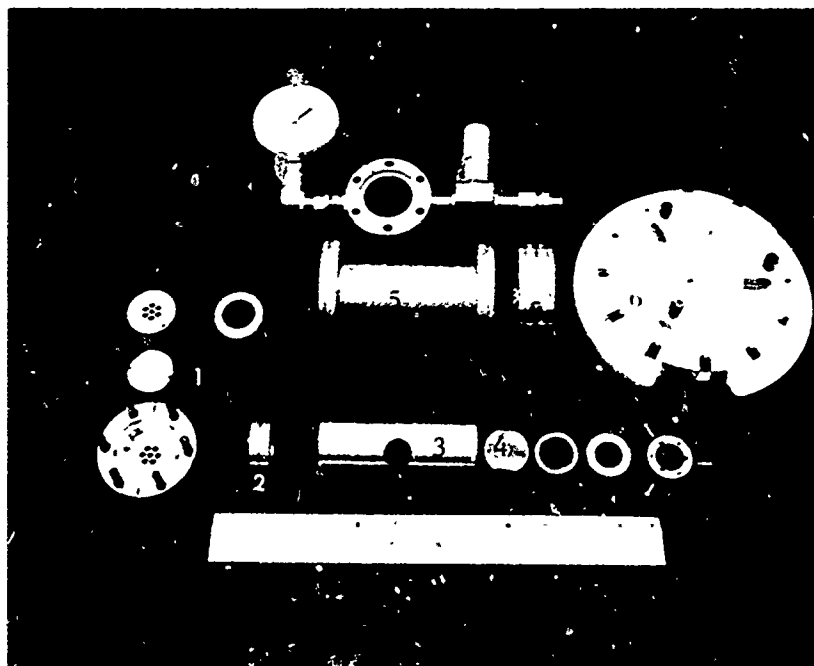


Figure 3. Longitudinal cavity and pressure cell (disassembled).  
(1) Titanium foil and support, (2) Mica mirror, (3) cavity, (4) Output coupler and mount, (5) Pressure cell, (6) Mounting fixture.



Reproduced from  
best available copy.

Figure 4. Photograph of longitudinal pressure cell (1) connected to faceplate of E-gun (2), and spectrometer (3).

4.2 Laser Diagnostics. The spectrum of the UV radiation from molecular xenon ( $\text{Xe}_2^*$ ) under excitation by a 2.3 MeV E-beam is shown in Figure 5, as a function of pressure. The actual spectrogram is shown in the corner while the densitometer traces of these spectra are shown with the corresponding pressure labeling. The Hg spectrum is shown to indicate the wavelength scale. For this purpose, the spectrograph was first dialed to read 3131A when the Hg spectrum was taken. The position of the 3131 doublet then coincided with the center of the film. To record the VUV spectrum the spectrograph was dialed back to 1750A reading, avoiding any backlash. With this method the position of the 3131A line in the Hg spectrum corresponds to the 1750A in the VUV spectrum.

Clearly the spectrum at lower pressure, viz. 50 psi ( $\sim 3.5$  atm) consists of a broad continuum nearly 150A wide and centered around 1750A. As the pressure is increased, the continuum narrows down. Finally at 300 psi the spectrum consists of  $\sim 50$ A wide continuum at about 1820A. The peculiar feature of this series of spectra is that at higher pressures, the spectrum appears to be narrower due to the absence of radiation at shorter wavelengths. Also the intensity decreases with spectral narrowing instead of an increase in intensity which would be expected in case of genuine line narrowing due to stimulated emission. Thus the nature of the spectrum appears to indicate some form of absorption. This indication was further substantiated when the same gas was run next day in the laser experiment. The spectra are shown in Figure 6. It is clear that even at the same pressure as before, viz., 300 psi, the spectrum shows well resolved bands at about 1850A, each band being 8-10A wide. The same feature is exhibited up to 500 psi.

The nature of the above spectra indicates that quite possibly the outgassing of the pressure vessel was introducing some trace of impurities. Oxygen is known to have sharp absorption bands in this spectral region where the xenon spectrum showed apparent line narrowing. For this reason the

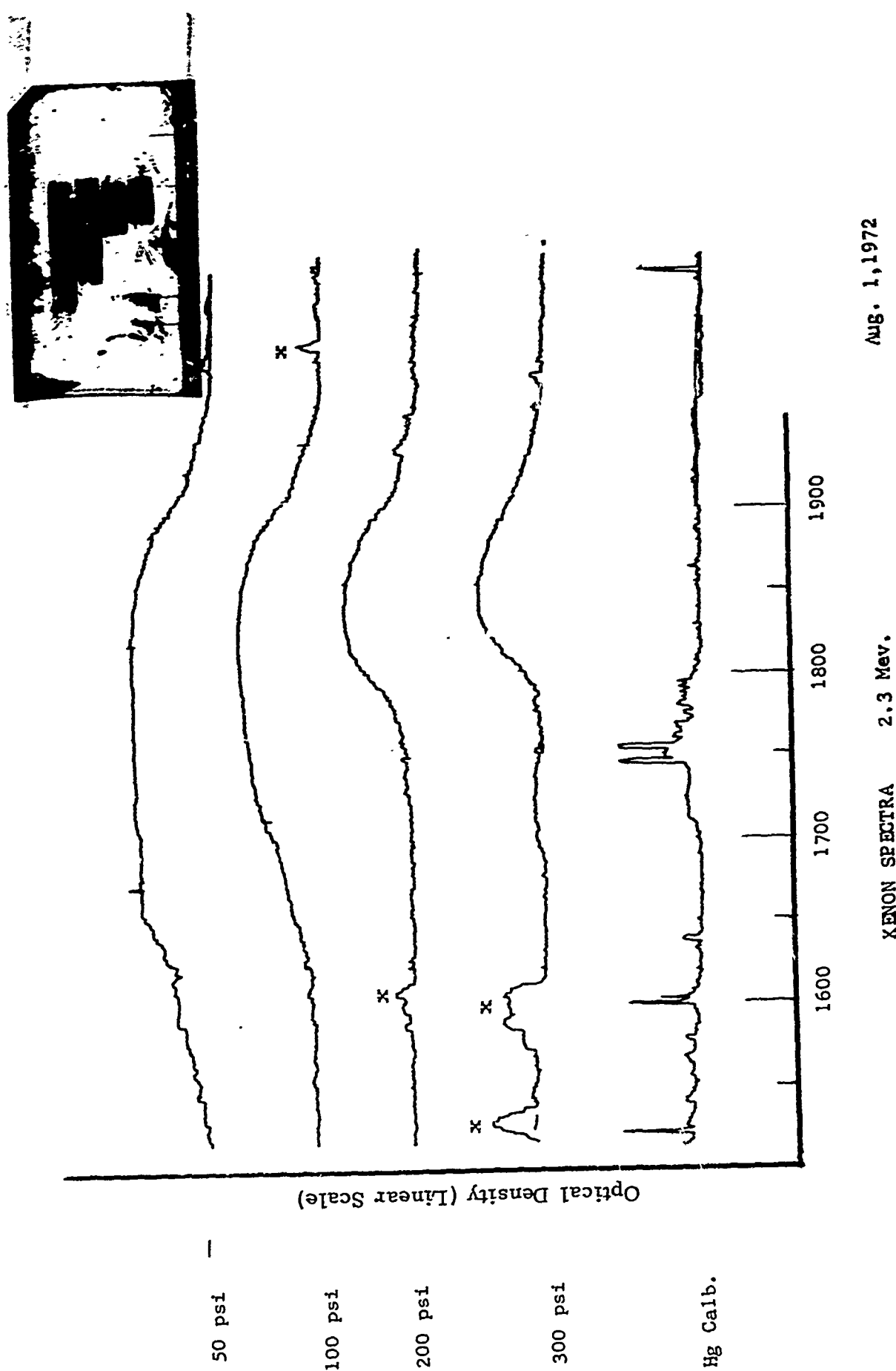


Figure 5. Densitometer traces of VUV molecular xenon emission spectra for 50 psig to 300 psig. The x's indicate optical density due to mechanical damage to the emulsion.

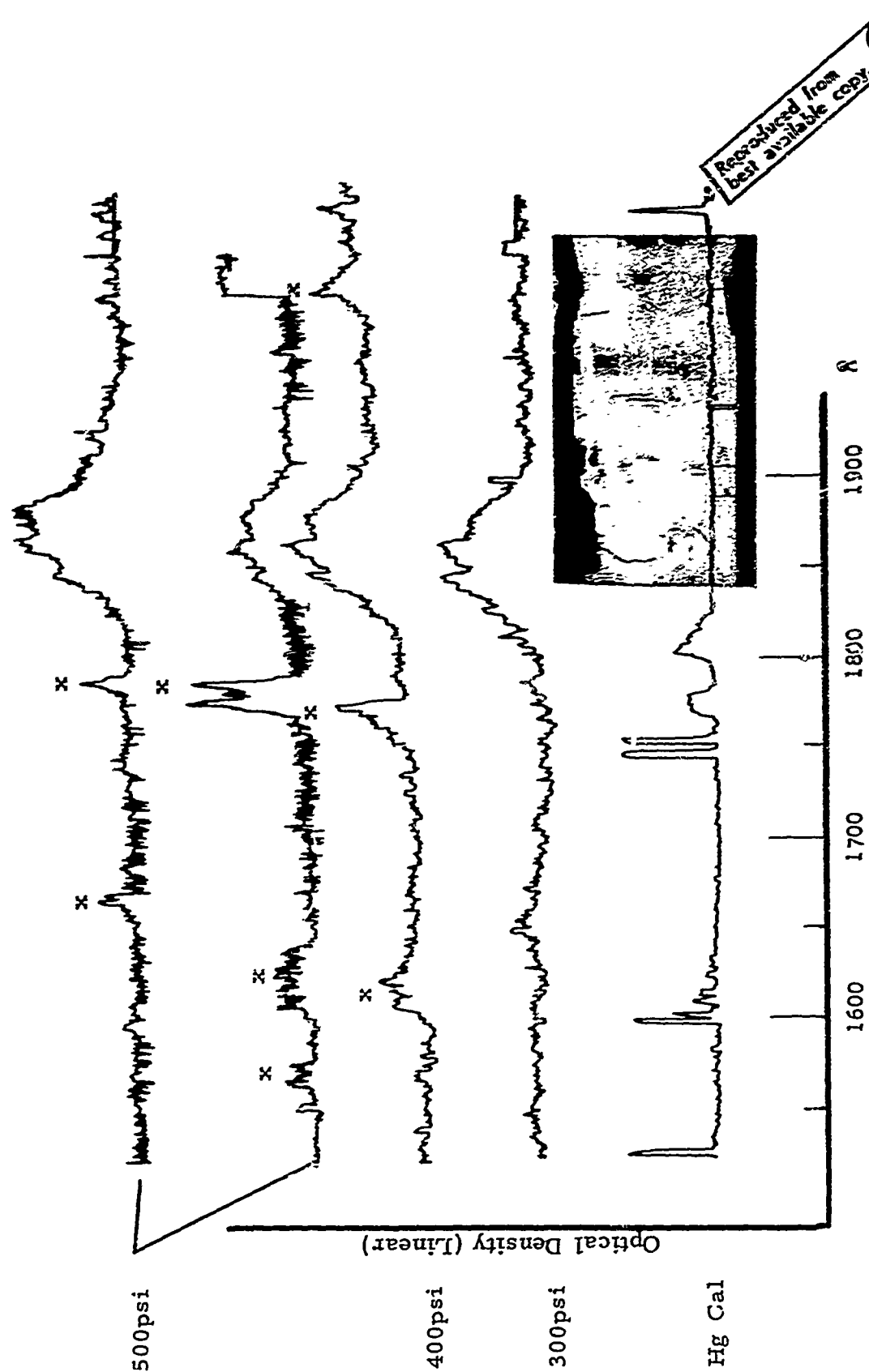


Figure 6. Densitometer traces of the VUV molecular xenon emission spectra for 300 psig to 500 psig. The x's indicate optical density due to mechanical damage.

the absorption spectrum of trace amounts of oxygen in 300 psi of argon was studied by using a broad band continuum from a high pressure xenon discharge lamp. The lamp continuum is shown in the spectrogram 7d (Figure 7). Spectrograms 7a and 7c show the continuum through 0.1% O<sub>2</sub> in 300 psi argon clearly exhibiting the O<sub>2</sub> absorption bands. Spectrogram 7b was taken with a somewhat higher O<sub>2</sub> concentration. Spectrogram 7e was obtained when the lamp continuum was passed through the high pressure xenon gas cell with the gas that was actually used for laser testing. The similarity of this spectrogram with 7a, 7b and 7c points to a tentative identification of the impurity as O<sub>2</sub> which is responsible for the apparent line narrowing observed in the xenon laser experiments.

Only fresh Xe gas was used in further experiments because of the problem described above. The spectrum of fresh Xe at 20 atm is shown in Figure 8. Although there is no significant line narrowing, the interesting point to note is that a preferential buildup of intensity at some wavelengths is discernible over a broad continuum. This may be an indication of incipient lasing. Note that the continuum shown in Figure 8 was obtained under the same experimental conditions as Figure 5 except for the use of fresh gas. The short wavelength absorption makes the continua in Figure 5 to appear centered at 1820A instead of 1750A as in Figure 8.

4.3 E-Beam Scattering. An estimate of the small signal gain, based on the analysis presented in the proposal NLSD 72-4P showed that stimulated emission from Xe<sub>2</sub><sup>\*</sup> should be observed under the experimental conditions described above. But the results only showed at best a marginal indication of lasing. This led to the suspicion that perhaps the E-beam current density was excessively reduced because of scattering by the foil and its support structure as well as by the high pressure gas. To get some measure of the

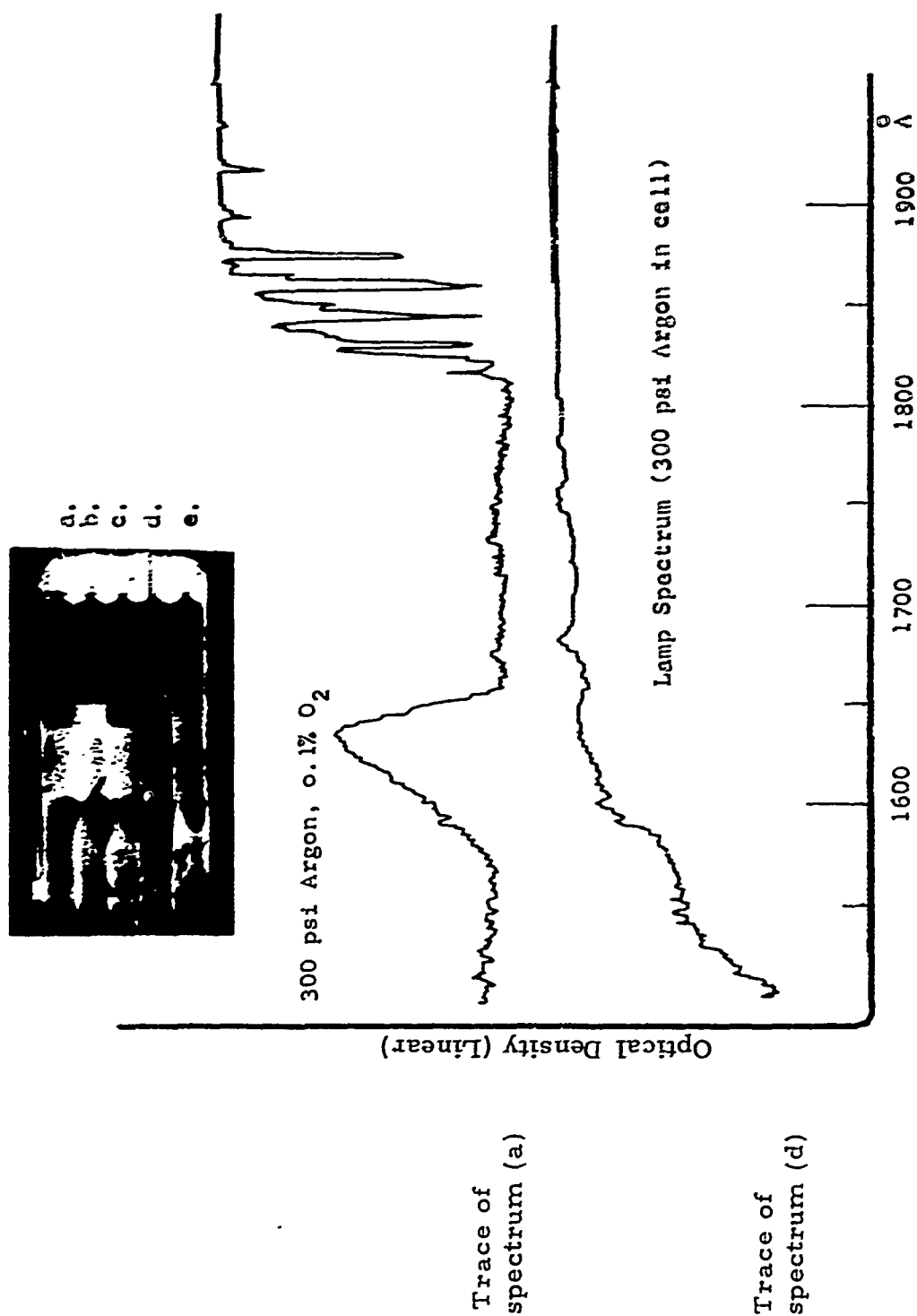
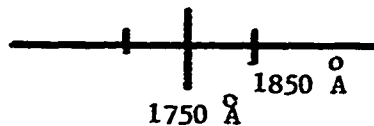


Figure 7. Spectra and selected densitometer traces showing the strong oxygen absorption bands near the expected xenon molecular continuum.



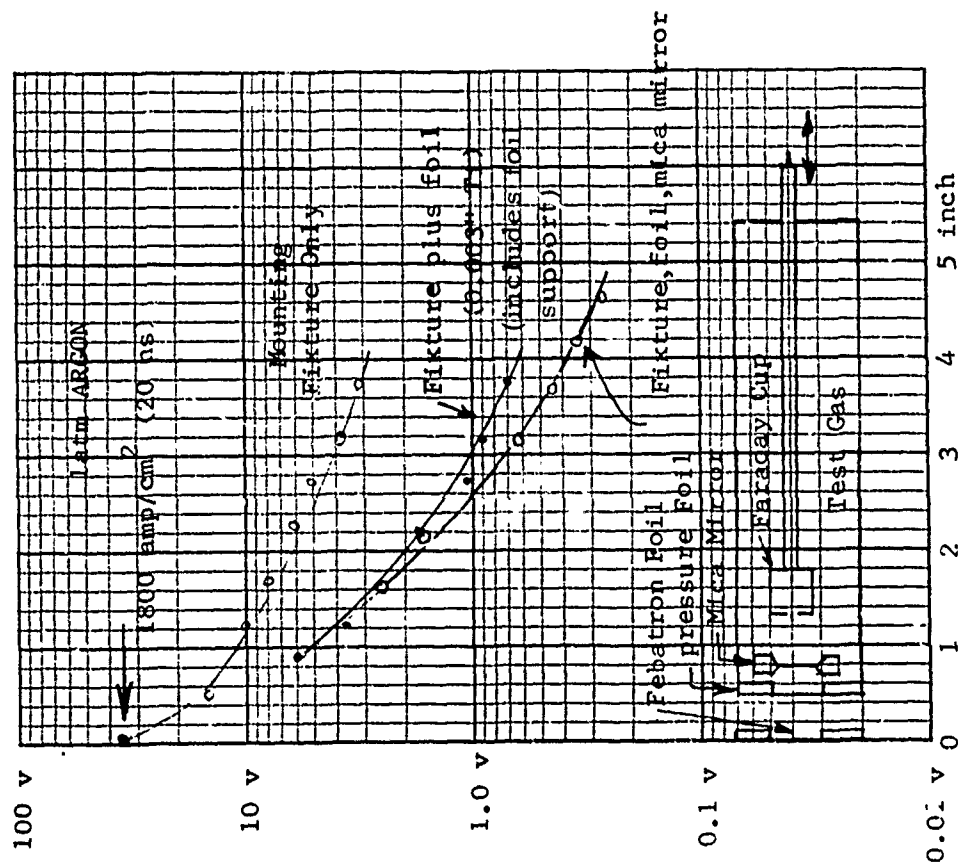
Reproduced from  
best available copy.

Figure 8. Spectra of uncontaminated xenon at 300 psig.  
a. This is the first shot on this fill gas, b  
through d are the next shots in sequence.  
(Note that the continua is centered at 1750Å  
compared to 1850Å as in Figure 5.) e. shows  
mercury calibration spectra.

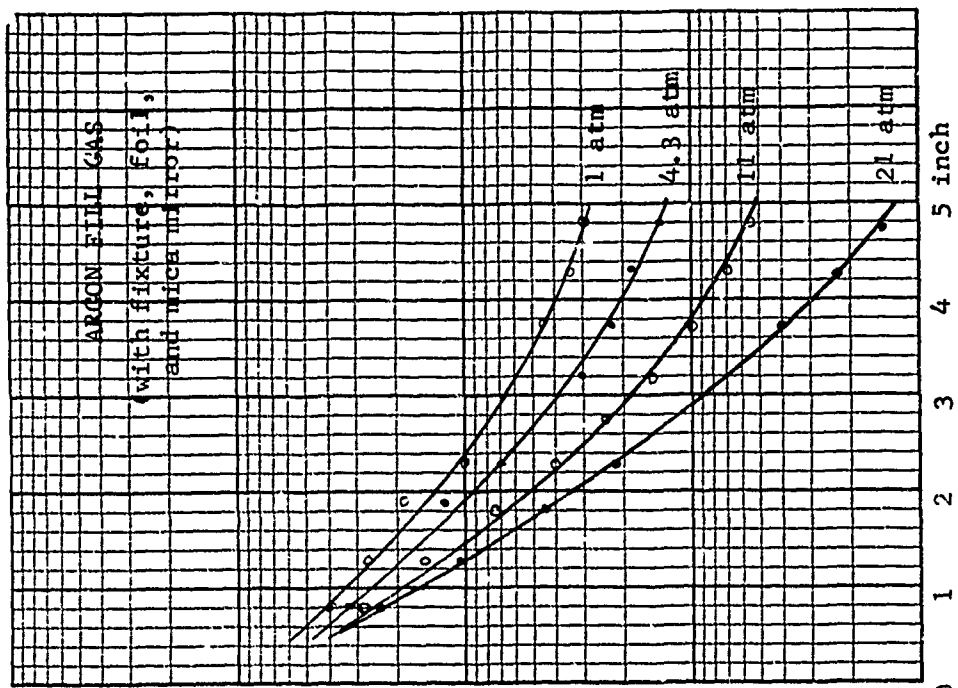
importance of scattering, the on axis electron current density was measured as a function of axial distance. A Faraday cup with a  $1 \text{ mm}^2$  entrance hole sampled the beam current within a test cell filled with argon. The relative locations of the pressure cell foil window, mica mirror, and Febetron foil are shown at the bottom of Figure 9a. It can be seen that the addition of the pressure cell window (0.003 inch titanium) causes a marked increase in the slope of the curve, indicating more scattering. The foil support is 60% open, this is in agreement with the transmission coefficient inferred from Figure 9a. For these data (the gas pressure is 1 atm) the stopping distance is about 10 meters, therefore, absorption is ruled out as a cause of the rapid decrease in beam current.

Figure 9b shows the effect of scattering due to high pressure gas. The slope of the curves increases with increasing pressure. Since the scattering depends strongly on atomic number, one would expect the current density to decrease even faster for xenon. (Argon was used in these tests for reason of economy.) So far no detailed analysis of the beam transport problem has been attempted because of its complexity.

These data (Figure 9) indicate that because of the rapid drop in beam current density only about the first 2-3 cm of the medium should have enough gain for lasing. Therefore, it was decided to abandon the longitudinal geometry and use a transverse cell. With this change the problem of using an electron transmitting mirror was eliminated and it was also possible to move the foil pressure window even closer to the Febetron foil.



(a)



(b)

FARADAY CUP VOLTAGE ON 0.01 mfd INTEGRATING CAPACITOR

2.3 MEV. 1 mm<sup>2</sup> APERTURE

Figure 9

## 5.0 TRANSVERSE EXCITATION

5.1 Cavity Design and Construction. The transverse cavity was designed using the same principles as the longitudinal one, except that the E-beam entered the cavity transversely. A schematic of the laser cell is shown in Figure 10. As before, the cavity was housed inside a pressure chamber. The radiation from the output window was directed to the spectrograph by a mirror at  $45^\circ$  angle to the beam.

The assembled laser cell is shown in Figure 11a and the entrance window is shown in Figure 11b. The E-beam enters the cavity through a 3 mil thick titanium foil window. The foil was supported by a perforated plate with an approximate obscuration ratio of  $\sim 40\%$ . The cavity was formed by two aluminum coated  $\text{MgF}_2$  flats placed 8 cm apart. Each cavity mirror was adjustable for alignment purposes and the alignment procedure was similar to that of the longitudinal cavity.

5.2 Laser Diagnostics. The spectrum of the pure Xe gas at 20 atm obtained in the transverse excitation scheme by a 2.3 MeV E-beam is shown in Figure 12a. This spectrum essentially shows the same features observed with the longitudinal excitation scheme. No significant line narrowing was seen except for some preferential buildup of intensity at several selective wavelengths. Figure 12b shows the Xe spectrum taken under exactly the same conditions described above except that the total reflector was taken out of the cavity. Significantly, the preferential buildup of intensity is absent in this spectrum. By comparing the spectra in Figure 12a and 12b it may be inferred that some evidence of incipient lasing is indicated under the experimental conditions employed in this investigation.

However, the possibility of a part played by some kind of absorption in producing the observed structure in the spectrum of Figure 12a cannot be

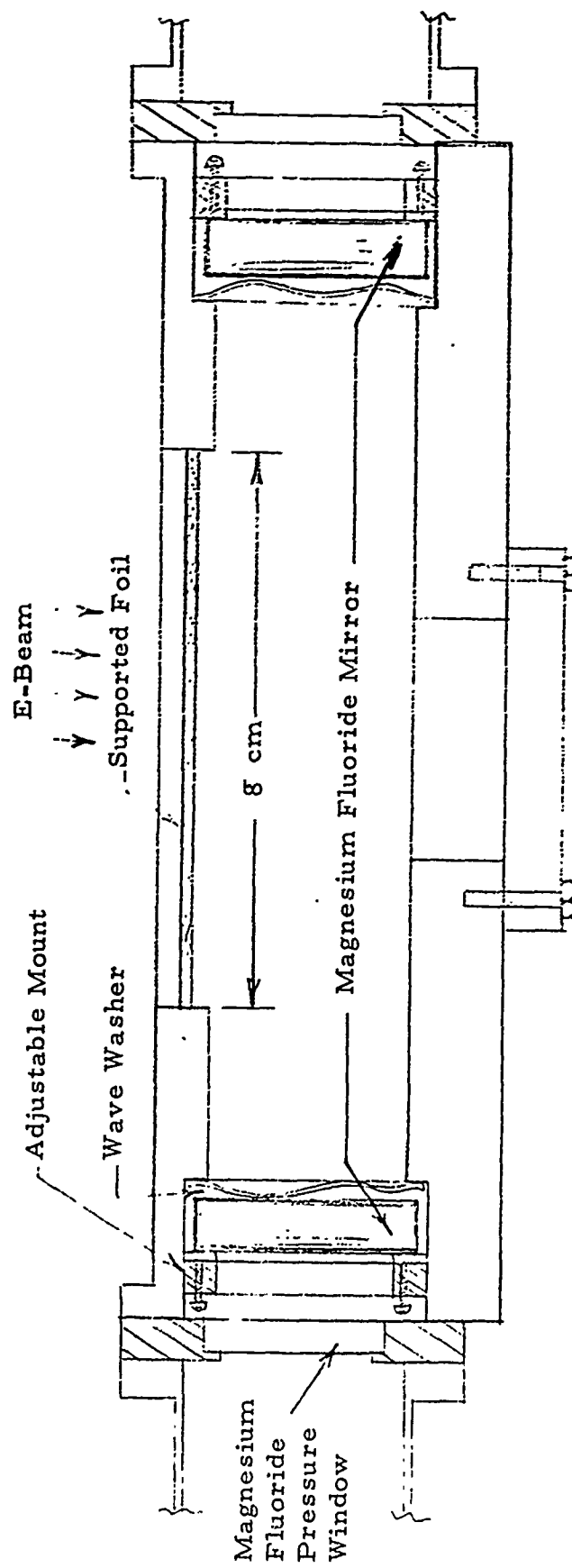
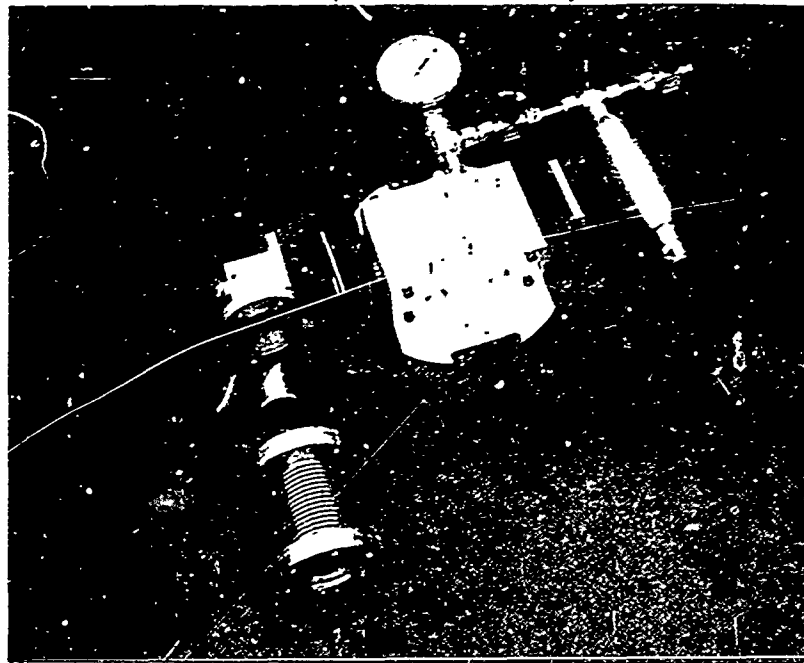
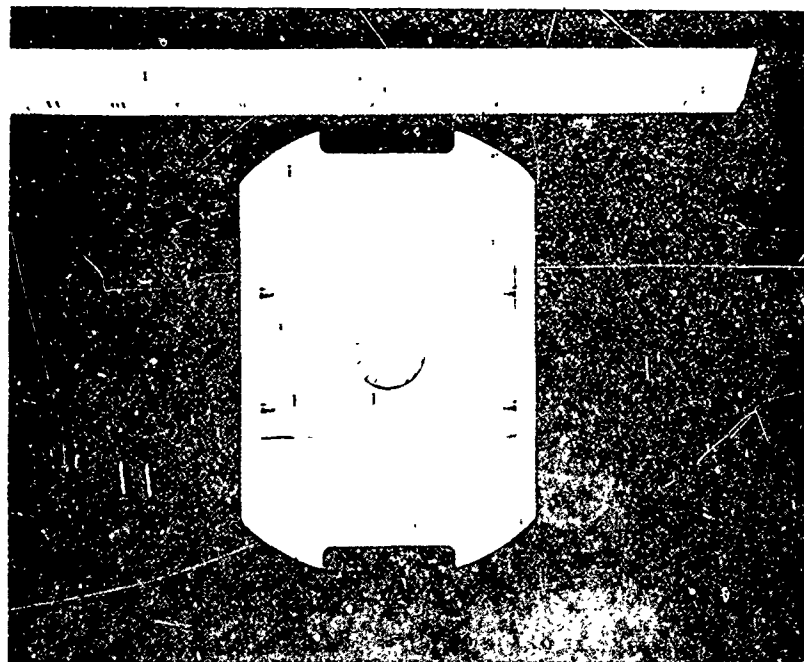


Figure 10. Transverse pressure cell.



(a)



(b)

Reproduced from  
best available copy.

Figure 11. (a) Transverse pressure cell, exploded view.  
(b) Photograph of foil and support.

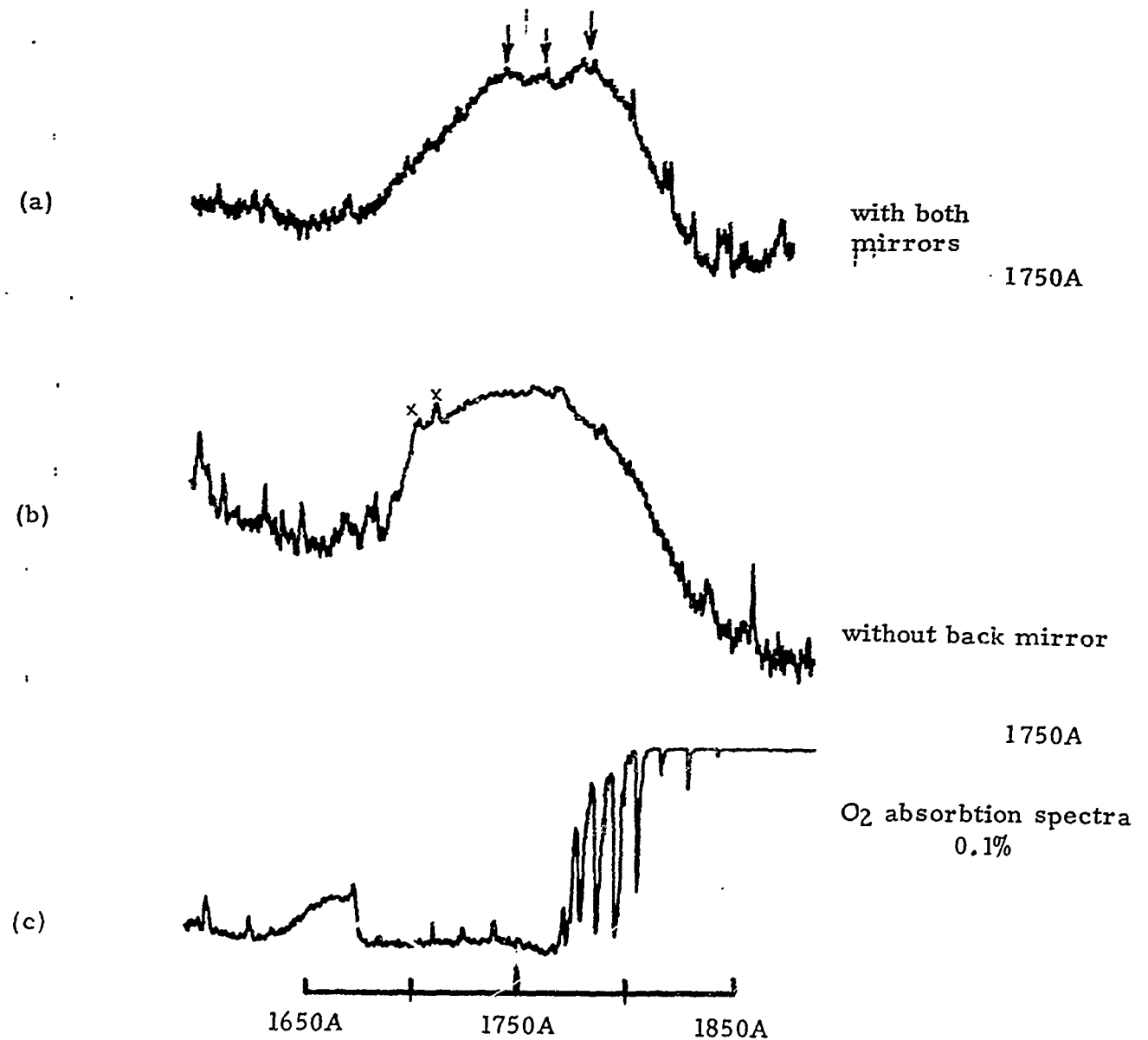


Figure 12. Densitometer traces of xenon continua.

- (a) Both mirrors in place; arrows indicate intensity peaks
- (b) Output coupler in place, other mirror removed.
- (c) Comparison O<sub>2</sub> absorbtion spectrum.

entirely ruled out. This is because, even in the absence of lasing, the radiation in the axial direction that reaches the spectrograph would go back and forth many times before emerging from the cavity (with both mirrors) thereby enhancing the effect of absorption. However, the wavelength interval between the intensity peaks of the observed spectrum (Figure 12a) is larger than that of the oxygen absorption spectrum (Figure 12c); this seems to rule out absorption due to  $O_2$  as the possible cause of the intensity variation in Figure 12a. Further experiments are necessary to determine if the structure in the continuum of Figure 12a could be due to absorption.

A new problem was encountered in the transverse excitation scheme. The  $MgF_2$  optics shattered after a few shots. This was probably due to excessive overpressure generated following the excitation pulse. In the longitudinal cavity, the stretching of the mica mirror might have reduced the overpressure. In fact when a 10 mil thick quartz mirror was used to replace the mica mirror, it shattered in the first shot although prior testing indicated that the quartz substrate was not damaged by the E-beam. An analysis of the pressure wave responsible for these damages is presented in the following section.

**5.3 Pressure Wave Analysis.** At pressures of 10 to 20 atm of xenon fill gas, the stopping power becomes large enough to cause an appreciable amount of electron beam energy to be absorbed by a small volume of gas. This energy ultimately heats the gas and causes an increase in the gas pressure inside the optical cavity. The pressure wave, which travels no more than a few times the speed of sound is slow enough that the pumping and lasing action would be over before the pressure wave reaches the optics. However, this pressure front may damage the optics, thereby preventing

any further experimentation until repairs are made. To estimate the magnitude of this effect let us assume that the heating occurs adiabatically during the short electron beam pulse ( $\sim 50$  ns). The change  $\Delta p$  in pressure of a perfect monatomic gas is given by

$$\Delta p = 2/3 \Delta u,$$

where  $\Delta u$  is the change in internal energy density of the gas. For the configuration used we estimate an energy deposition of  $\sim 1$  J/cm<sup>3</sup>. The corresponding pressure increase is then expected to be about 6.7 atm.

Although we have not studied this phenomenon in detail, its effects are evidenced by ruptured foils and broken optics. In the longitudinal configuration the mica mirror was permanently distorted after test runs at 10-20 atm. (Note that in all the high pressure configurations the optical cavity is housed in a pressure cell so it sees no static pressure load.) With an improved foil mount the beam energy input was sufficient to shear the steel pins holding the output mirror cell as well as rupture the mica mirror. After breaking several magnesium fluoride mirrors with the transverse configuration, it was decided to use vacuum ultraviolet grade quartz. This material withstands the overpressure in the tests made to date. Experiments are now in progress using the quartz mirror.